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With regard to the definition, the detail on the planet is not so well given as in the Lick photographs, though closely approaching in the best photographs to this. With an enlargement to a diameter of ·8 of an inch, the satellites are fairly round, and about the proportionate size, though rather faint, the exposure being about 7^s. These photographs were taken with this exposure for the planet, and I did not expect to see any trace of the satellites. Photographs taken on this night, September 8, at short intervals of time, show Sat. II. emerging from the limb, while the shadow is still visible on the disc. When the satellite is well clear, the shadow seems to cut a piece out of the limb.

Another photograph on September 10 shows this with Sat. III. in a similar manner.

Several photographs taken on September 15 show Sat. II. and its shadow in transit. The red spot shows in a most marked manner in many. From an examination of the enlarged image of the planet, and also of the limb of the Moon, it appears to me that definition depends very much on the atmospheric conditions. In looking at the image enlarged on very fine ground glass, there are moments when the image is very sharp and steady. Then the image becomes blurred, and good definition disappears for a few seconds. The nights have been too few to determine whether this is a permanent condition of things, probably there may be nights when the definition is good continuously.

The Reappearance of Saturn's Ring. By the Rev. A. Freeman, M.A.

With the aid of a 6-inch refractor by Simms, lent to me by the Royal Astronomical Society, and having a focal length of 7 feet and a magnifying power of 180, I have fortunately obtained very fine views of *Saturn* in the early mornings of October 29, 30, 31, November 2 and 3. The sky was unhappily overcast on November 1, and from November 4 to 9. The description of what was seen follows:—

October 29, $5^h\ 55^m$ A.M. (civil time).—*Saturn's* elliptical disc is crossed by a dark band, its breadth about one-tenth of the length of the polar diameter of the planet. The north edge of this band seems to be on the equator of the planet. The equatorial bright belt, which is yellowish, seemed about half the breadth of the dark band, which is, of course, the unilluminated north side of the rings. I could see no division in this band. The first southern dusky belt is visible, and the rest of *Saturn's* disc is of a pale white colour except at the poles, which are dusky. The crescent moon is only about 4° to the east of *Saturn* and nearly at the same altitude. *Titan* ceased to be visible at $6^h\ 30^m$.

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October 30, 6^h^ 10^m^ A.M. to 6^h^ 20^m^ A.M.—The best view at 6^h^ 15^m^ A.M. The broad dark band across *Saturn's* elliptical disc is wholly south of the equator, with its north edge almost on the equator. The band is very sharply defined, and is of an indian-ink colour, the general colour of the brighter parts of *Saturn* pale white, that of the equatorial bright belt a pale yellow. The breadth of the band estimated to be one-tenth of the length of the polar diameter. The south edge of the band seemed to be *very slightly curved*, with convexity southwards. The breadth of the equatorial bright belt is to-day about two-thirds that of the dark band. Two dusky belts visible south of the dark band and one north. The north pole a shade darker than the south pole.

October 31, 6^h^ 25^m^ to 6^h^ 35^m^ A.M.—The view at 6^h^ 30^m^ A.M. showed the broad dark band very distinctly, its north edge on *Saturn's* equator. The yellowish equatorial bright belt north of the equator *is as broad as the band*, which seems a little narrower than yesterday. The distance of the band from a dusky belt south of it is equal to the breadth of the band. There is not to-day, nor was there on the two previous days, any trace whatever of the ansæ of *Saturn's* ring. At 6^h^ 32^m^ A.M. a remarkable bright round spot was entering over the east limb of *Saturn* upon the equatorial bright belt, and it was wholly within the limb and wholly upon the bright belt at 6^h^ 36^m^. It appears to follow spot 2^a^ of Mr. A. S. Williams's spots (*Astron. Nach.* No. 3051) about half a rotation. Mr. Williams confirms this view.

November 1, 6^h^ A.M.—The sky wholly overcast with clouds. The same was the case, as I am informed, at Cambridge Observatory.

November 2, 5^h^ 30^m^.—On the very first view the ring was plainly visible as a fine bluish line of some breadth on the preceding side, its length about five-eighths of the diameter of *Saturn*; it was also seen, but not so easily, as a faint bluish narrower line on the following side, and of nearly the same length. The power used was 150 only. *Enceladus*, *Tethys*, *Rhea*, *Titan* and *Iapetus* were also visible. (*Dione* was not seen separate from *Rhea*, it was probably closer to *Rhea* than the 8″ which would be given by Marth's Ephemeris.) I soon changed to the higher power of 180, which also has better definition, and at 5^h^ 45^m^ A.M., I found the breadth of the blue ansæ at the limb to be equal to that of the dark band, very nearly if not quite. The colour of the ansæ was a vivid electric-light blue, streaked with white in general direction nearly parallel to *Saturn's* equatorial axis. The white was probably the colour reflected by the brightest parts of the inner and outer rings. I saw that the dark band was divided near the limbs of the planet by fine bright lines, one near each limb, but I could not with certainty trace the division right across the dark band. The bright division could not, according to Trouvelot, represent a view of *Saturn* seen through the Cassini gap; it was probably the bright outer rim of the inner ring. Two dusky belts south

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and one north, the poles dusky. At 5h 50m the equatorial bright belt seemed rather brighter than the equally broad bright space on the other side of the dark band, whose breadth was the same also. At 5h 58m A.M. I perceived that the north edge of the dark band had a deep orange tint, and there seemed to be a short semi-elliptic bright segment cut out of this orange border at about its middle. The orange tint is that of *Saturn* seen through the crape ring. Both ansæ continued to be easily visible till 6h 5m A.M.; they became faint at 6h 9m, and flashed out occasionally at 6h 13m, as did also *Rhea* and *Tethys*. The preceding ansa was the more easily caught sight of at 6h 20m A.M., when *Titan* was only just perceptible, a light haze now coming up. At about 6h 0m A.M. I had perceived bright projections, one on each ansa; that on the preceding ansa, about halfway, was possibly due to the atmosphere of the ring, that on the following ansa, near its E. end, may have been *Mimas*.

November 3, 5h 25m A.M.—The blue ansa west of *Saturn* seen through light cloud, *Tethys* E., *Titan* W. At 5h 28m very good definition (with power 180), *Mimas*, *Rhea*, *Dione* closely followed the E. end of the ring, the blue ansa east being very plainly seen also. (*Enceladus* too close to *Saturn* to be detected.)

At 5h 38m both ansæ visible. At 5h 48m both ansæ alternately visible through thin passing cloud. At 5h 53m I noticed the colour of the equatorial belt to be yellow, the rest of *Saturn* pale white, except where dark band and dusky belt S. and N. cross it, the N. belt very faint. The dark band is again seen to be orange tinted on its N. edge. *Dione* and *Rhea* could be seen at 5h 59m; but at 6h 11m, in spite of the light haze, both ansæ were more easily visible than those two satellites. The preceding ansa, the south dusky belt, dark band, and bright equatorial belt remained visible up to 6h 31m, when *Titan* could be only glimpsed through the haze.

From these circumstances, I am confident that if the blue ansæ had been visible to any telescope at all comparable with that in my charge on the morning of October 31, I should have seen them. It has been already stated that they came into view immediately on the morning of November 2. I conclude, therefore, that the plane of *Saturn's* rings probably passed through the Sun's centre on November 1, at about 6 A.M., or possibly one hour, or two hours at most, earlier. From the heliocentric longitude (172° 6′ 17″·0) and heliocentric latitude (2° 8′ 38″·3 N.) of *Saturn*, October 31, 18h G.M.T. (astronomical time), and with an inclination 28° 10′ 11″·4 of the ring plane to the ecliptic for $1891\frac{5}{6}$, which is derived from Bessel's formula (with the values of δn, δi and m, stated by Professor J. A. C. Oudemans to be the correct solution of Bessel's own equations (in *Monthly Notices of the Royal Astronomical Society*, December, 1888, page 57), I infer that the node of *Saturn's* rings on the ecliptic, when the ring-plane passed

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through the Sun, was in longitude 168° 5′ 45″·7.* I may mention that Professor Oudemans has kindly informed me, by letter dated November 6, that with his 9½-inch refractor, at Utrecht, he had a clear view of *Saturn* on the Friday morning and saw no ring, that Saturday (October 31) was overcast, and on Sunday morning he once, for a moment only, at $5^h\ 10^m$ A.M. (G.M.T), fancied he saw the ring through passing clouds, but Monday again was overcast, and he did not see the ansæ until Tuesday morning. His observations confirm the inference I had reported to him as derivable from my own views of *Saturn* on the mornings of Saturday, October 31, and Monday, November 2.

Murston Rectory, Sittingbourne :
1891 *November* 9.

Comparative Photographic Spectra of the Sun and the Metals. Series I. and II. By F. McClean, M.A.

I wish to lay before the Society two series of photographic spectra, in which the spectra of the Sun and of the fifteen metals enumerated are mounted in parallel sections, in order to facilitate their comparison and the identification of their lines. The spectra extend from wave-length 3,800 to wave-length 5,750 tenth metres, or from above (H) to near (D).

Series I. contains spectra of the Sun, iron, platinum, iridium, osmium, palladium, rhodium, ruthenium, gold and silver. The last eight constitute the platinum group of metals.

Series II. contains the spectra of the Sun, iron, manganese, cobalt, nickel, chromium, aluminium and copper. These seven metals constitute the iron-copper group.

Each series consists of six sections, corresponding to six sections of Ångstrom's chart.

The broad lines and bands which run uniformly across all the metallic spectra are due to the air. This spectrum is always present when the induction spark is taken between metal electrodes in the air. Its lines and bands are coarser, relatively to the other lines, than in the original negative. This is due to their prominence and consequent over-exposure in the negative. A special series of photographs are requisite to obtain the air spectrum relatively at its best, but as it is shown here it will bear comparison with the existing maps of it.

Before the true spectra of the metals can be arrived at, it is necessary to further eliminate the lines due to various impurities in the specimens of the metals employed as electrodes. Iron

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* Bessel's equations, corrected as above, give 168° 4′ 16″·1 as the longitude of the node for 1891$\frac{5}{6}$. The difference seems probably attributable more to the unknown nutation of the ring, caused by all the satellites, than to the small disturbing precessional influence exercised by the Sun and *Iapetus*.